# Algae from the Cave of Mátyás Mount, Budapest, Hungary

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*With plate 36 (I) and one figure in the text*

The 250 meter high Mátyás Mount forms a part of the Buda Mountains, located on the Northwest part of Budapest in the vicinity of Obuda. The entrance of the cave of Mátyás Mount opens on the southwest slope of the Mátyás Mount, 203 meters above sea level on the bottom of an abandoned stone quarry. The total length of its known corridors is 2,310 meters. The deepest point in the cave is occupied by a lake (Silty Lake), the altitude of which is between 111–112 meters, dependent upon the rainfall. The corridors leading to the lake form complicated labyrinths of tectonic origin, similarly to the two other main branches, "Mud Houlding" and "Compass Corridors." The approximately ten meter square surface of the two meter deep lake receives its water supply from two directions, from the west from the "T-rift" – "Mud Houlding Corridors", while from the east from the difficultly traversable irregularities formed in the fissures of the "Compass Corridor". The original formation of the cave was in tectonic fissures which were further developed through water erosion. Both the four large corridor systems of the upper level and the heavily broken fissures of the lower level have their main direction in the NW-SE and NE-SW line. Though the different investigators have somewhat varying opinions in regards to the exact mode and time of origin of the cave, they agree that due to the eruptions of hot springs as a result of tectonic movements these have a secondary role in the cave's formation. The appearance of the formations in the upper und lower levels are quite and well distinguishable. The upper level is dry and is characterized by rounded off forms, large rooms and narrow isthmi. The lower one is wet with the results of heavy tectonic movements and signs of cold water karst erosion. The level of the lake water corresponds to the nivo of the first karst water flow. The lowest level of the cave's corridors (Silty River and Lake) was developed in upper Triassic hornstone

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limestone. The greatest portion of the corridor systems, however, can be found in the upper Eocene nummulinic limestone, whereas the uppermost levels of the entrance areas were developed in bryozoic marl and in the marl conglomerates of Buda. (Schafarzik, Vendl, Papp, 1964, pp. 93–95.)

The material investigated was kindly supplied by L. Hajdu, speleologist. I wish to express my gratitude at this place to Mr. Hajdu for supplying me with this interesting sample. Hajdu's collections came partly from "Silty Lake" and partly from the formations around the lake: "Great Traverse", "Sugar Cane", and "Compass Corridor." The collected material which contained both scrapings and scooped water was transported in sterile bottles to my laboratories where they were filled with sterile, modified Knop's solution and placed on the sill of a west facing window. The localities of the collections and the environmental factors pertaining to the different habitats will be reported in details elsewhere (Hajdu, 1965) and in the present paper only their enumeration is given.

1. Water from Silty Lake.
2. Water from Silty River below Great Traverse.
3. Scraping from vicinity of Sugar Cane.
4. Water from pool in vicinity of Sugar Cane.
5. Wall scraping from 15 meters high in vicinity of Sugar Cane.
6. Scraping from "smut spot" in Compass Corridor I.
7. Scraping from "smut spot" in Compass Corridor II.

The numbers of the collections employed in the present paper correspond to those used by Hajdu.

Immediately after the receipt of the collections, microscopic preparations were made from them in order to test whether or not the algae lived in forms of resting stages or spores in the cave or occurred actively vegetating. These preparations showed that although very few algal cells were found, they were colored and appeared fully developed. They did not occur in resting stages. After three weeks, due to the rapid development of the algae, the contents of the cultures became colored and allowed us to investigate the species present in them without the tedious method of looking through quantities of preparations that is required for algal identifications in native cave samples.

The algal species and intraspecific taxa found in the cave are enumerated in taxonomical order. After a short description of the form, a number indicates the locality of the collection and another refers to its depiction.

## Taxonomic Part

*CYANOPHYTA*

Glococapsaceae

*Gloeocapsa minuta* (Kütz.) Hollerb.

Cells solitary, spherical in a non-layered capsule, 3–4 μ, with capsule 6–8–10 μ in diameter, bluish-green. Nos. 3, 4, 5. Fig. 1.

*Gloeocapsa bituminosa* (Bory) Kütz.

Thallus mucilaginous, brown. Cells brownish, spherical up to 4 μ in diameter, 4–6 μ with capsule, capsule colorless, non-layered. No. 7. Fig. 2.

Chlorogloeacea

*Chlorogloea microcystoides* Geitler

Thallus thin, mucilaginous. Cells more or less spherical, or somewhat oppressed, densely packed and giving the impression of distinct rows in a common hyaline sheath, bluish, 3–3.5 μ in diameter. No. 1. Fig. 3.

Nostochopsidaceae

*Baradlaia speluncaecola* Palik.

Filaments in the beginning flexible, later when they deposit more or less amounts of calcium carbonate in their sheaths, rigid. (Figs. 4a, 4c.) 1.2–1.5 μ wide, after incrustation with lime 2 μ or even seldom 5 μ in width (Fig. 4d). Filaments with arthrospores 2 μ wide (Fig. 4b). The length of the erect filaments varies: 16.5–33 μ. Their apical portion often bends upwards while the surface of the older filaments, due to the heavy lime incrustation is usually covered with small protrusions. Filaments usually branching, sometimes even multiple branchings occur, this may be found on more than one side of the filament; the side branches emerge at a right angle to the filamental axis. The young trichomes are bluish in color. The crosswalls can be made visible only with staining; the cells are longer than wide. Propagation with arthrospores (Fig. 4b) or with the fragmentation of the filaments. Nos. 2, 3, 4, 5, 6, 7. Figs. 4a. b, c, d.

Scytonemataceae

*Tolypothrix bouteillei* (Brèb. et Desmaz.) Lemm.

Filaments joined in blackish brown thalli. The filament is about 5 μ wide, with a narrow colorless sheath, the side branches can often and easily become disjointed. Cells 4 μ wide, barrel shaped, somewhat

shorter than wide. At the basal portion of the trichome, a single heterocyst occurs. Nos. 3, 5. Fig. 5.

*CHRYSOPHYTA*

Bacillariophyceae
Fragilariaceae

*Fragilaria capucina* Desmaz. var. *lanceolata* Grun.

Valve lanceolate, 24 μ long, 3.5 μ wide, gradually tapering towards the ends and obtusely rounded off, with 15 transapical striae in 10 micra. Central area angular, pseudoraphe threaded. No. 1. Fig. 6.

Naviculaceae

*Cymbella ventricosa* Kütz.

Valve 19 μ long, 6.5 μ wide, dorsal side convex, while the ventral side is almost straight. Apices pointedly rounded off, slightly bent towards the ventral side. Raphe straight, somewhat closer located to the ventral side. In the central area of the ventral side one small stigma observable. Fourteen transapical striae in 10 μ. No. 7, Fig. 7.

*Gomphonema parvulum* (Kütz.) Grun.

Valve more or less club shaped, 17 μ long, 7 μ wide, axial area narrow, central area developed only on one side; opposite to it a solitary stigma. Transapical striae radiate, 14 of them in 10 μ. No. 7. Fig. 8.

Nitzschiaceae

*Hantzschia amphioxys* (Ehr.) Grun.

Valve 36–40–43 μ long, 9–10 μ wide, dorsal side slightly convex, ventral concave. Valve towards the ends tapering. Apices slightly capitate. 8 "Kielpunkte" in 10 μ, the two middle ones located somewhat distantly from each other; 14 transapical striae in 10 μ. Nos. 1, 6. Fig. 9.

*CHLOROPHYTA*

Chlorophyceae
Chlorococcaceae

*Chlorococcum humicolum* (Näg.) Rabenh.

Cell spherical, 5–20 μ in diameter, solitary. After division, often 4 or more cells together. Chromatophore spherical, at places with outcuts on it, with one pyrenoid. Reproduction either with cell division or

with zoospores. Zoospores 2–3 μ wide, 5 μ long, with two equal flagella. Nos. 1, 3, 6, 7, Figs. 10a, b.

Chlorellaceae

*Chlorella vulgaris* Beyer.

Cells spherical with approximately 7–10 μ diameter. Usually solitary, with thin wall and with a bell shaped chromatophore. During reproduction the cell contents divides into 2, 4, or 8 portions. No. 3. Figs. 11a, b.

Oocystaceae

*Oocystis pusilla* Hansg.

Cell elongated, elliptical, 3–6 μ wide, 8–11 μ long, usually solitary, sometimes, however, two cells remain together encased in the mother cell wall. Nos. 2, 3, 4. Fig. 12.

*Oocystis rupestris* Kirchn.

Cell elongated elliptical, 16–22 μ long, 8–12 μ wide, usually solitary, sometimes after division 4 cells can be found together encased in the mother cell wall. No. 2. Fig. 13.

Scenedesmaceae

*Scenedesmus ecornis* (Ralfs) Chod.

Cell elliptical or oval shaped, 7 μ long, 3.5 μ wide, coenobium composed of four cells. Sometimes two celled coenobia were also observed in which the cells were 9 μ long, and 4 μ wide. Nos. 1, 4. Fig. 14a, b.

*Scenedesmus incrassatulus* Bohl.

Cells having the shape of a rounded off triangle. The neighboring cells attached to each other by almost the entire length of their longest sides, 13 μ long, 4.5 μ wide, coenobia two celled. No.1. Fig. 15.

*Scenedesmus arcuatus* Lemm.

Cell approximately 9 μ long and 4 μ wide. Coenobium composed of 4 cells, bent, at the attachment points of the cells, small pores visible. No. 1. Fig. 16.

*Scenedesmus apiculatus* (W. et W.) Chod.

Cell 9 μ long, 4.5 μ wide, with a small capitate protrusion at one end. Coenobium composed of four cells, but often also solitary cells can be found. No. 1. Fig. 17a, b.

*Scenedesmus falcatus* Chod.

Cell elongated, having the form of a spindle, 12 μ long, 4 μ wide, with pointed apices. Two atypical coenobia: 1., cells 8 μ long, 3 μ wide, eight cells in a coenobium, forming two alternate rows of 4; 2., Cell 11 μ long, 2.5 μ wide, forming four celled coenobia. Nos. 1, 2. Figs. 18a, b, c.

*Scenedesmus intermedius* Chod. var. *acaudatus* Hort.

Cells 8–9 μ long, 3–5 μ wide, coenobium composed of four alternating, more or less drop shaped cells. No. 1. Fig. 19.

Ulothrichaceae

*Ulothrix subtillissima* Rabenh.

Relatively long filaments; cells 4 μ wide, 7–9 μ long, with a single parietal chromatophore having one pyrenoid. Nos. 3, 7. Fig. 20.

Fig. 1

*Stichococcus bacillaris* Näg.

Short filaments composed of 2–4, seldom more cells which often completely fragment into single cells, ends obtusely rounded. Cells 3–4 μ wide, 6–7 μ long, with 1 parietal chromatophore. Nos. 3, 7. Fig. 21.

The collections resulted in the identification of 21 algal species or varieties, of which 12 belong to the Chlorophyta, representing 57 per cent of the total. The percentage distribution of the three identified algal phyla are shown in Text Figure 1. The different species occurring in the different localities in the cave are compiled in Table 1.

According to its algal composition, the cave of Mátyás Mount shows a certain resemblance to the nearby cave of Pálvölgy, at least in the respect that in both of these caves the numbers of the Chlorophyta comprised more than half of the total algal population. Though in both caves the activity of hot springs in their formation is postulated by geologists and as a possible result of this in the cave of Pálvölgy Suba (1957) found several thermophilic algae, no such species occurred in the cave of Mátyás Mount. Even the individual species of these two caves do not agree well. In the cave of Pálvölgy the different *Ankistrodesmus* forms were the dominating Chlorophytes whereas in the cave investigated by me the *Scenedesmus* species seem to be most prevailing.

Since in the cave of Pálvölgy no permanent water flow occurs, and this seems to be the chief distinguishing feature between these two closely located and through their origin allied caves, the differences of their floral composition might rest in this fact.

Table 1.

Algal Occurrences in the Cave of Mátyás Mount

| Name of species found | Locality Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| *Baradlaia speluncaecola* Palik | | + | + | + | + | + | + |
| *Chlorella vulgaris* Beyer. | | | + | | | | |
| *Chlorococcum humicolum* (Näg.) Rabenh. | + | | + | | | + | + |
| *Chlorogloea microcystoides* Geitler | + | | | | | | |
| *Cymbella ventricosa* Kütz. | | | | | | | + |
| *Fragilaria capucina* Desmaz. var. *lanceolata* Grun. | + | | | | | | |
| *Gloeocapsa bituminosa* (Bory) Kütz. | | | | | | | + |
| *Gloeocapsa minuta* (Kütz.) Hollerb. | | | + | + | + | | |
| *Gomphonema parvulum* (Kütz.) Grun. | | | | | | | + |
| *Hantzschia amphioxys* (Ehr.) Grun. | + | | | | | + | |
| *Oocystis pusilla* Hansg. | | + | + | + | | | |
| *Oocystis rupestris* Kirchn. | | + | | | | | |
| *Tolypothrix bouteillei* (Brèb. et Desmaz.) Lemm. | | | + | | + | | |
| *Scenedesmus apiculatus* (W. et W.) Chod. | + | | | | | | |
| *Scenedesmus arcuatus* Lemm. | + | | | | | | |
| *Scenedesmus cornis* (Ralfs.) Chod. | + | | | + | | | |
| *Scenedesmus falcatus* Chod. | + | + | | | | | |
| *Scenedesmus incrassatulus* Bohl. | + | | | | | | |
| *Scenedesmus intermedius* Chod. var. *acaudatus* Hort. | + | | | | | | |
| *Stichococcus bacillaris* Näg. | | | + | | | | + |
| *Ulothrix subtilissima* Rabenh. | | | + | | | | + |
| Total taxa: 21 | 10 | 4 | 8 | 4 | 3 | 3 | 7 |

SUMMARY

Seven collections containing scrapings of speleoclay or samples from the cave waters were received from L. Hajdu and were cultured in light in a modified Knop's solution. The cultures yielded 21 different algal taxa, of which five species belong to the Cyanophyta four to the Bacillariophyceae class of the Chrysophyta and twelve to the Chlorophyta. From the species distribution the cave shows a similarity to the nearby cave of Pálvölgy, namely both of them contained more than 50 per cent Chlorophyta. Among the Cyanophyta the occurrence of *Baradlaia speluncaecola* Palik is noteworthy. This species seems to be a true troglobitic alga, since the genus is known only from caves.

## ZUSAMMENFASSUNG

Sieben Sammlungen, die Abschabungen von Höhlen oder Proben von Höhlenwasser enthielten, wurden von L. Hajdu erhalten und unter Licht in einer modifizierten Knop-Lösung kultiviert. Von den Kulturen wurden 21 verschiedene Algentaxa erhalten, von denen fünf Species zu den Cyanophyten, vier zu der Bacillariophyceae-Klasse der Chrysophyten und 12 zu den Chlorophyten gehörten. Die Verteilung der Species ist ähnlich der in der naheliegenden Höhle von Pálvölgy, die beide mehr als 50% Chlorophyten enthalten. Unter den Cyanophyten ist das Erscheinen von *Baradlaia spelunceecola* Palik bemerkenswert. Diese Species scheint eine echte troglobyte Alge zu sein, da das Genus nur von Höhlen bekannt ist.


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## EXPLANATION OF PLATE I

Fig. 1: *Glococapsa minuta* (Kütz.) Hollerb.

Fig. 2: *Glococapsa bituminosa* (Bory) Kütz.

Fig. 3: *Chlorogloea microcystoides* Geitler.

Fig. 4: *Baradlaia speluncaecola* Palik.
a: flexible filament portion with the beginnings of side branches.
b: arthrospores in the filament.
c: portion of a lime encrusted branching filament.
d: heavily lime encrusted filament portion with the remnants of two side branches.

Fig. 5: *Tolypothrix boutellei* (Bréb. et Desmaz.) Lemm.

Fig. 6: *Fragilaria capucina* Desmaz. var. *lanceolata* Grun.

Fig. 7: *Cymbella ventricosa* Kütz.

Fig. 8: *Gomphonema parvulum* (Kütz.) Grun.

Fig. 9: *Hantzschia amphioxys* (Ehr.) Grun.

Fig. 10: *Chlorococcum humicolum* (Näg.) Rabenh.
a: mature cell or cell undergoing division.
b: swarmers.

Fig. 11: *Chlorella vulgaris* Beyer.

Fig. 12: *Oocystis pusilla* Hansg.

Fig. 13: *Oocystis rupestris* Kirchn.

Fig. 14: *Scenedesmus ecornis* (Ralfs) Chod.
a: two celled coenobium.
b: four celled coenobium.

Fig. 15: *Scenedesmus incrassatulus* Bohl.

Fig. 16: *Scenedesmus arcuatus* Lemm.

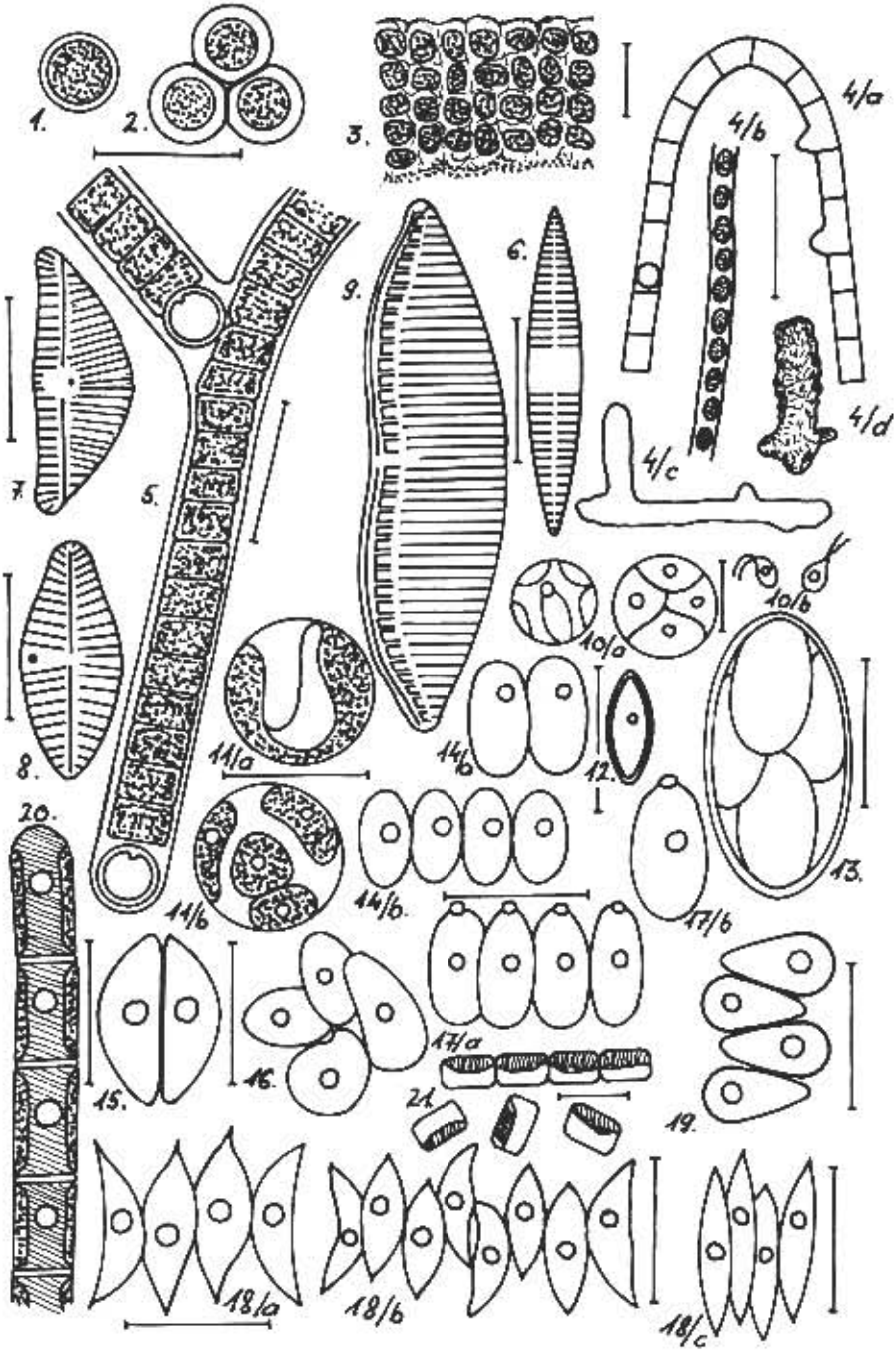
Fig. 17: *Scenedesmus apiculatus* (W. et W.) Chod.
a: four celled coenobium.
b: solitary cell.

Fig. 18: *Scenedesmus falcatus* Chod.
a: typical four celled coenobium.
b: eight celled coenobium.
c: four celled coenobium composed of narrow cells.

Fig. 19: *Scenedesmus intermedius* Chod. var. *acaudatus* Hort.

Fig. 20: *Ulothrix subtilissima* Rabenh.

Fig. 21: *Stichococcus bacillaris* Näg.
(The lines at the sides of the figures represent 10 μ.)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